

Effects of temperature during seed development in *Lactuca sativa* and *Helianthus debilis*.

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INTRODUCTION

Among the factors affecting seed quality are the environmental conditions under which the seeds are produced. Several reports indicate that differences in temperature, water availability and daylength during seed development affect seed quality, especially dormancy and germinability. In general, the consensus is that higher temperatures during seed development reduces dormancy and improves germination (Fenner 1991, Hilhorst and Toorop 1997, Gutterman 2000). The objective of this study was to determine how the temperature during seed development affects seed germinability in lettuce (*Lactuca sativa*) and *Helianthus debilis*.

MATERIAL AND METHODS

Seeds of lettuce cv. Tango and *Helianthus debilis* cv. Vanilla Ice and ssp. *cucumerifolius* were produced in a greenhouse under one of two treatments: i) **hot** (27, 40, and 20°C average, max, and min respectively), and ii) **cool** (23, 33, and 18°C average, max, and min respectively). In the case of lettuce, two sowing dates (replications) were performed, with 21 plants per temperature treatment on each date. In the case of *Helianthus*, 12 plants per each line and temperature were used, and self-pollination was assisted manually with a brush. For both species fully mature seed were harvested manually and seed dry weight (oven method, 103°C) and germination (defined as radicle emergence) at optimal and sub-optimal conditions were determined. For lettuce, 20°C and constant light was considered optimal conditions, whereas 20/30°C and constant light was the optimal for *Helianthus*. With the exception of the dark germination test in lettuce, where just final germination percentage was evaluated, for all other tests the germination was evaluated daily and total germination percentage and germination index (GI; algebraic sum of the ratio of germinated seeds and days after sowing at the count moment) were calculated.

Table 1. Lettuce seed quality after development at two different temperatures.

Parameter	Treatment (temperature)		p-value
	Hot	Cool	
Seed dry weight (mg/seed)	0.66	0.79	0.006
Germination at 20°C (%)	100	100	0.423
Germination Index at 20°C	1.00	0.95	0.401
Germination at 30°C (%)	72	18	0.020
Germination Index at 30°C	0.43	0.08	0.046

Table 2. *Helianthus debilis* seed quality after development at two different temperature treatments (hot vs. cool). Values are average ±SE.

Parameter	<i>H. debilis</i> cv. Vanilla Ice		<i>H. debilis</i> ssp. <i>cucumerifolius</i>	
	Hot	Cool	Hot	Cool
Dry weight (mg/seed)	7.41 ±0.03	7.89 ±0.19	7.41 ±0.09	7.79 ±0.09
Germination (%)	88 ±2	80 ±0	100 ±0	100 ±0
Germination Index	0.15 ±0.01	0.13 ±0.00	0.19 ±0.01	0.20 ±0.00

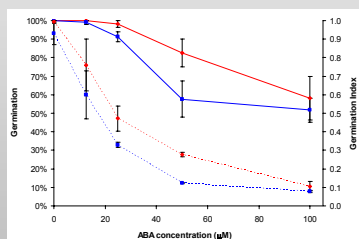


Figure 1. Germination (solid line) and germination index (broken line) of lettuce seeds from hot (red) and cool (blue) temperature treatments at different ABA concentrations. Bars represent SE.

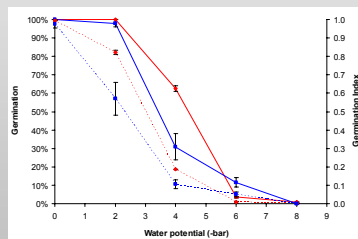


Figure 2. Germination (solid line) and germination index (broken line) of lettuce seeds from hot (red) and cool (blue) temperature treatments at different water potentials (PEG solutions). Bars represent SE.

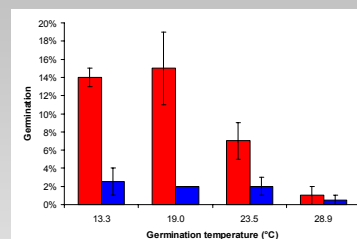


Figure 3. Dark germination of lettuce seeds from hot (red) and cool (blue) temperature treatments at different temperatures. Bars represent SE.

RESULTS AND DISCUSSION

In both species heavier seeds were produced under the cool conditions (Tables 1 and 2). No differences in lettuce germination at optimal conditions were observed, however at 30°C the germination percentage and GI was higher for seeds from the hot treatment (Table 1). In the case of *H. debilis*, 'Vanilla Ice' showed an improved germination percentage and GI when seed developed at higher temperatures, while ssp. *cucumerifolius* did not show differences (Table 2).

In lettuce, total germination and GI were both affected by increased levels of exogenous ABA concentrations and reduced water potential (PEG solutions), and in both cases seeds from cool treatments were more affected (Figures 1 and 2). Lettuce seed showed a strong light requirement for germination; however, seeds from the hot treatment gave better dark germination at 13.3, 19.0 and 23.5°C (Figure 3). On the other hand, seeds of *H. debilis* did not require light for germination. In this species, germination was evaluated at 13, 21, and 29°C. For *H. debilis* ssp. *cucumerifolius* there were no differences in germination at any of the temperatures evaluated (Figure 4b). In the case of *H. debilis* 'Vanilla Ice', germination was higher at 29°C for seeds produced at the hot temperature (Figure 4a).

The results showed that temperature during seed development affected certain aspects of seed quality that are undetected by the standard germination test, but are revealed by germination tests at suboptimal conditions. Within the Asteraceae family, seed quality differences varied among and within species. Current research is attempting to discover the mechanisms that may be governing observed differences between seeds produced at contrasting temperature conditions.

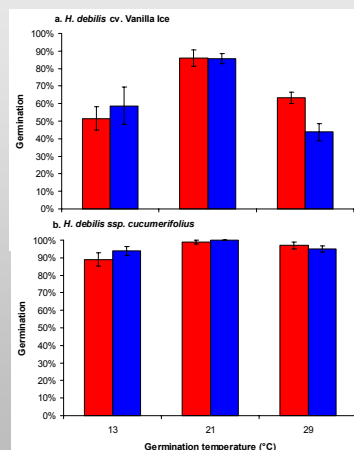


Figure 4. Seed germination of *H. debilis* cv. Vanilla Ice (a) and ssp. *cucumerifolius* (b) from hot (red) and cool (blue) temperature treatments at different temperatures. Bars represent SE.

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